International Journal of Agricultural Science and Research (IJASR)
ISSN (P): 2250-0057; ISSN (E): 2321-0087
Vol. 7, Issue 3, Jun 2017, 247-252
© TJPRC Pvt. Ltd.

TRANS STELLAR •Journal Publications •Research Consultancy

EFFECT OF NUTRIENT DEFICIENCIES ON GROWTH OF GERBERA THROUGH SOLUTION CULTURE

SAI RATNA SHARAVANI. CH[1], NEERAJA PRABHAKAR. B[2] & CHANDINI PATNAIK. M[3]

[1]*Department of Floriculture and Landscape Architecture, S.K.L.T.S.H.U, Hyderabad, Telangana, India*

[2]*Department of Horticulture, P.J.T.S.A.U, Hyderabad Telangana, India*

[3]*Department of Soil Science and Agricultural Chemistry, P.J.T.S.A.U, Hyderabad, Telangana, India*

ABSTRACT

Gerbera is one of the commercial cut flowers, widely cultivated under low cost protected structures. Due to its continuous feeding habit, it suffers from many deficiency disorders in the green houses. Hence, the present investigation was carried out to know the influence of nutrient deficiencies on growth and nutrient uptake of Gerbera var. Savannah through solution culture. Plants were treated with complete modified Hoagland solution and deficiencies were incorporated with a complete nutrient formula minus one of the nutrient. Nitrogen deficiency significantly influenced the growth parameters and resulted in reduced plant height, leaf number plant^{-1}, leaf area, root length, dry weight of shoot and root & shoot/root ratio. Besides, minimum SLW and maximum SLA were recorded. Plants grown in complete nutrient solution recorded maximum values for most growth parameters. However, SLA was lower in plants grown in complete nutrient solution, whereas, shoot/root ratio recorded maximum in Fe deficient solution.

***KEYWORDS:** Gerbera, Solution Culture, Hoagland Solutions, Growth & Nutrient Uptake*

Received: Apr 14, 2017; **Accepted:** May 13, 2017; **Published:** May 25, 2017; **Paper Id.:** IJASRJUN201731

Original Article

INTRODUCTION

Gerbera (Asteraceae) is indigenous to South Africa and Asia as a perennial herb, mostly inhabiting temperate and mountainous regions. In India, they are distributed in the temperate Himalayas from Kashmir to Nepal at altitudes from 1,300 to 3,200 m. Gerbera occupies fourth place among cut flowers as per global trends in floriculture (Sujatha *et al.,* 2002). It is an important commercial flower grown throughout the world and in India, Assam is having the largest area under cultivation (600 ha) and Telangana is the major cut flower producer (6.01 lakhs) (Anonymous, 2014-15). It is ideal for pot, rock gardens, borders and beds.

For commercial production, Gerberas are considered as moderate feeders. This moderate level of fertility produces a plant with a proportional leaf area to flower ratio. Any increase or decrease in nutrient supply results in abnormal growth and yield loss thereby highlighting the need of balanced nutrition. Knowledge of nutrient deficiencies in growth would assist the grower in problem identification. Qualitative techniques, as visual diagnosis is very useful to detect an individual problem, but when visual symptom shows up, some reduction in yield has already been caused. For this reason, quantitative technique such as failure analysis is preferred. Balancing the needs of the plant and periodic monitoring will help in assuring the implementation of nutritional requirements. Information about effect of nutrient deficiencies in Gerbera var. Savannah and critical nutrient levels have not been found in literature. Hence this experiment is aimed to elucidate the influence of different nutrient deficiencies on the

growth of Gerbera.

MATERIALS AND METHODS

An experiment was conducted at the Floricultural Research Station, Rajendranagar of Telangana state during 2016-17, using tissue cultured Gerbera var. Savannah. Plants which were grown prior to treatment in peat based compost were used in the present investigation. Plants of uniform size with 3-4 leaf stage were selected. Twelve treatments *viz.* Complete modified Hoagland solution and complete minus N, P, K, CA, Mg, S, Mn, B, Fe, Zn, Cu was used to incorporate deficiencies (Hoagland and Arnon, 1950). The nutrient treatments were arranged in a completely randomized design with 12 plants each treatment. Nutrient solutions were replaced at weekly intervals and volume is maintained by adding distilled water. Observations regarding leaf area, root length, dry weight of shoot and root, shoot/root ratio, specific leaf area and specific leaf weight were recorded at the end of the experiment *i.e.,* 60 DAT by using the formulas as follows

$$\text{Shoot/ Root Ratio} = \frac{\text{Dry weight of shoot}}{\text{Dry weight of root}}$$

$$\text{SLW} = \frac{\text{Leaf dry weight}}{\text{Leaf area}}$$

$$\text{SLA} = \frac{\text{Leaf area}}{\text{Leaf dry weight}}$$

The data was analyzed by using software OPSTAT in CRD

RESULTS

Nitrogen Deficiency

There was significant reduction in the growth of plants grown in N deficient treatment compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (12.5 cm, 23.3 cm), leaf number (4.33, 12.67), leaf area (19.67cm^2, 41.34 cm^2), root length (14.6 cm, 27.83 cm), dry weight of shoot (0.140 g, 0.563 g), root dry weight (0.06 g, 0.203 g), shoot/root ratio (2.33, 2.77) & specific leaf weight (0.28 mg cm^{-2}, 0.39 mg cm^{-2}). Whereas, specific leaf area was recorded higher compared to complete (3.56 cm^2 mg^{-1}, 2.58 cm^2 mg^{-1}).

Phosphorus Deficiency

There was significant reduction in the growth of plants grown in P deficient treatment compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (13.53 cm, 23.3 cm), leaf number (6.33, 12.67), leaf area (21.33 cm^2, 41.34 cm^2), dry weight of shoot (0.257g, 0.563 g), root dry weight (0.080 g, 0.203 g), & specific leaf weight (0.338 mg cm^{-2}, 0.39 mg cm^{-2}). Whereas, root length (32.20 cm, 27.83 cm), shoot/root ratio (3.21, 2.77) & specific leaf area (2.96 cm^2 mg^{-1}, 2.58 cm^2 mg^1) was recorded higher compared to plants grown in complete nutrient solution.

Potassium Deficiency

There was significant reduction in the growth of plants grown in K deficient treatment compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (15.30 cm, 23.3 cm), leaf number (6.67, 12.67),

leaf area (27.43 cm^2, 41.34 cm^2), root length (22.80 cm, 27.83 cm), dry weight of shoot (0.287 g, 0.563 g), root dry weight (0.093 g, 0.203 g), & specific leaf weight (0.317 mg cm^{-2}, 0.39 mg cm^{-2}). Whereas, shoot/root ratio (3.07, 2.77) & specific leaf area (3.15cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Calcium Deficiency

There was significant reduction in the growth of plants grown in CA deficient treatment compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (14.60 cm, 23.3 cm), leaf number (6.00, 12.67), leaf area (24.35cm^2, 41.34 cm^2), root length (17.17 cm, 27.83 cm), dry weight of shoot (0.310g, 0.563 g), root dry weight (0.117 g, 0.203 g), shoot/root ratio (2.66, 2.77) & specific leaf weight (0.304 mg cm^{-2}, 0.39 mg cm^{-2}), whereas, specific leaf area (3.30 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Magnesium Deficiency

There was significant reduction in the growth of plants grown in Mg deficient treatment compared to complete treatment (Table1 & 2). Decreased values were recorded for plant height (16.47cm, 23.3 cm), leaf number (7.67, 12.67), leaf area (30.73 cm^2, 41.34 cm^2), root length (19.70 cm, 27.83 cm), dry weight of shoot (0.377g, 0.563 g), root dry weight (0.120g, 0.203 g), & specific leaf weight (0.337 mg cm^{-2}, 0.39 mg cm^{-2}), whereas, shoot/root ratio (3.15, 2.77) & specific leaf area (2.97 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Sulphur Deficiency

There was significant reduction in the growth of plants grown in S deficient treatment compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (15.77cm, 23.3 cm), leaf number (7.67, 12.67), leaf area (31.38cm^2, 41.34 cm^2), root length (19.50cm, 27.83 cm), dry weight of shoot (0.367g, 0.563 g), root dry weight (0.127g, 0.203 g) & specific leaf weight (0.306mg cm^{-2}, 0.39 mg cm^{-2}), whereas, shoot/root ratio (2.90, 2.77) & specific leaf area (3.26 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Manganese Deficiency

There was significant reduction in the growth of plants grown in Mn deficient treatment compared to complete treatment (Table1 & 2). Decreased values were recorded for plant height (21.03 cm, 23.3 cm), leaf number (10.00, 12.67), leaf area (36.77 cm^2, 41.34 cm^2), root length (25.27 cm, 27.83 cm), dry weight of shoot (0.470g, 0.563 g), root dry weight (0.170g, 0.203 g) & specific leaf weight (0.354 mg cm^{-2}, 0.39 mg cm^{-2}). There was no significant difference observed regarding the shoot / root ratio of men deficient treatment and complete (2.76, 2.77), whereas specific leaf area (2.83 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Boron Deficiency

There was significant reduction in the growth of plants grown in B deficient treatment as compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (20.57 cm, 23.3 cm), leaf number (9.00, 12.67), leaf area (33.55 cm^2, 41.34 cm^2), root length (21.43 cm, 27.83 cm), dry weight of shoot (0.433 g, 0.563 g), root dry weight (0.157 g, 0.203 g) & specific leaf weight (0.351 mg cm^{-2}, 0.39 mg cm^{-2}). There was no significant difference observed regarding the shoot / root ratio of men deficient treatment and complete (2.76, 2.77), whereas specific leaf area (2.84 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Iron Deficiency

There was significant reduction in the growth of plants grown in Fe deficient treatment as compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (14.46 cm, 23.3 cm), leaf number (6.33, 12.67), leaf area (32.59 cm^2, 41.34 cm^2), root length (15.50 cm, 27.83 cm), dry weight of shoot (0.297 g, 0.563 g), root dry weight (0.090 g, 0.203 g) & specific leaf weight (0.333 mg cm^{-2}, 0.39 mg cm^{-2}), whereas, shoot/root ratio (3.29, 2.77) & specific leaf area (3.00 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Zinc Deficiency

There was significant reduction in the growth of plants grown in Zn deficient treatment as compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (19.57 cm, 23.3 cm), leaf number (9.33, 12.67), leaf area (35.38 cm^2, 41.34 cm^2), root length (25.80 cm, 27.83 cm), dry weight of shoot (0.497 g, 0.563 g), root dry weight (0.177 g, 0.203 g), shoot/root ratio (2.51, 2.77) & specific leaf weight (0.324 mg cm^{-2}, 0.39 mg cm^{-2}), whereas, specific leaf area (3.07 cm^2 mg^{-1}, 2.58 cm^2 mg^1) was recorded higher compared to plants grown in complete nutrient solution.

Copper Deficiency

There was significant reduction in the growth of plants grown in Cu deficient treatment as compared to complete treatment (Table 1 & 2). Decreased values were recorded for plant height (17.27 cm, 23.3 cm), leaf number (8.00, 12.67), leaf area (34.63 cm^2, 41.34 cm^2), root length (22.57cm, 27.83 cm), dry weight of shoot (0.497g, 0.563 g), root dry weight (0.177 g, 0.203 g) & specific leaf weight (0.331 mg cm^{-2}, 0.39 mg cm^{-2}), whereas, shoot/root ratio (3.02, 2.77) & specific leaf area (3.02 cm^2 mg^{-1}, 2.58 cm^2 mg^1) recorded higher compared to plants grown in complete nutrient solution.

Table 1: Effect of Nutrient Deficiencies on Plant Height, Leaf Number, Leaf Area & Root Length of Gerbera Var. Savannah

Treatments	Plant Height (cm)	Leaf Number	Leaf Area (cm^2)	Root Length (cm)
T_1(Complete)	23.3	12.67	41.34	27.83
T_2 (-N)	12.50	4.33	19.67	14.60
T_3 (-P)	13.53	6.33	21.33	32.20
T_4(-K)	15.30	6.67	27.43	22.80
T_5 (-Ca)	14.60	6.00	24.35	17.17
T_6 (-Mg)	16.47	7.67	30.73	19.70
T_7 (-S)	15.77	7.67	31.38	19.50
T_8 (-Mn)	21.03	10.00	36.77	25.27
T_9 (-B)	20.57	9.00	33.55	21.43
T_{10} (-Fe)	14.46	6.33	32.59	15.50
T_{11} (-Zn)	19.57	9.33	35.38	25.80
T_{12} (-Cu)	17.27	8.00	34.63	22.57
S Em ±	0.142	0.272	0.126	0.172
C D at 5%	0.416	0.799	0.369	0.504

Table 2: Effect of Nutrient Deficiencies on Dry Weight of Shoot and Roots, Shoot/Root Ratio, Specific Leaf Weight (SLW), Specific Leaf Area (SLA) of Gerbera Var. Savannah

Treatments	Dry Weight of Shoot (g)	Dry Weight of Root (g)	Shoot/Root Ratio	SLW (mg cm^{-2})	SLA (cm^2 mg^{-1})
T_1(Complete)	0.563	0.203	2.77	0.387	2.58
T_2 (-N)	0.140	0.060	2.33	0.280	3.56
T_3 (-P)	0.257	0.080	3.21	0.338	2.96
T_4(-K)	0.287	0.093	3.07	0.317	3.15
T_5 (-Ca)	0.310	0.117	2.66	0.304	3.30
T_6 (-Mg)	0.377	0.120	3.15	0.337	2.97
T_7 (-S)	0.367	0.127	2.90	0.306	3.26

Table 2: Contd.,

T_8 (-Mn)	0.470	0.170	2.76	0.354	2.83
T_9 (-B)	0.433	0.157	2.76	0.351	2.84
T_{10} (-Fe)	0.297	0.090	3.29	0.333	3.00
T_{11} (-Zn)	0.497	0.177	2.51	0.324	3.07
T_{12} (-Cu)	0.413	0.137	3.02	0.331	3.02
S Em ±	0.006	0.003	0.09	0.001	0.04
C D at 5%	0.018	0.009	0.265	0.002	0.012

DISCUSSIONS

In the above experiment, there has been great reduction in growth of plants subjected to N deficiency, followed by other macro nutrients, since nitrogen plays a key role in vegetative growth of plants due to its involvement of N in formation of amino acids, proteins and protoplasm *i.e.,* site of cell division. Therefore, N deficiency results in poor growth and development (Uchida, 2000), which had resulted in reduced plant height, similar reduction in plant height due to nitrogen deficiency was observed in Gerbera (Jeong *et al.*, 2009) and in Hibiscus (Hossain *et al.,* 2010). Nitrogen is mobile and translocates from older to younger leaves, which resulted in severe defoliation and reduced leaf number. Similar reduction in leaf number due to deficiency of nitrogen was observed in *Spathyphyllum* (Yeh *et al.,* 2000) and Hibiscus (Hossain *et al.,* 2010). Reduction in leaf area in N deficient plants is due to poor carbon assimilation as N is a major part of the chlorophyll molecule and is necessary for photosynthesis (Uchida, 2000). A similar reduction in leaf area due to nitrogen deficiency was observed in *Anthurium* (Keng *et al.,* 2012) and in *Spathyphyllum* (Yeh *et al.,* 2000). Increase in root length under P stress was due to several adaptive changes of root *i.e.,* root elongation due to diversion of photosynthates towards root in search of phosphorous (Fredeen *et al.,* 1989), a similar observation of increase in root length due to P deficiency was reported in Chilli (Prasad *et al.,* 1987). Minimum root length due to N deficiency was also observed in Cucumber (Zhang *et al.,* 2012). Nitrogen being a major element is required in greater amounts (Taiz and Zeigar, 2003) for photosynthesis, vegetative growth and improvement of dry matter production (Uchida, 2000), it's deficiency affects several processes, mainly photosynthesis, which ultimately leads to lower the biomass production (Hossain *et al.*, 2010), hence deficiency resulted in reduced shoot and root dry weight. Shortage of N restricts the vegetative growth deficiency results in low shoot-root ratio. Shoot-root ratio recorded highest in Fe deficient treatment. This may be due to increased dry weight of shoot than root. Minimum SLW in N deficient treatment was due to limited accumulation of dry matter in the leaves (Lizarazo *et al.,* 2013). Plants grown in complete nutrient solution had shown increase in growth as plants were supplied with all macro and micronutrients. Effect of manganese deficiency did not influence much on growth; similar observations were recorded by Jeong *et al.* (2009) in Gerbera**.** Since Mn is required in minute amounts (Salisbury and Ross, 1986) and does not affect chloroplast breakdown (Julia *et al.,* 2006).

CONCLUSIONS

Nitrogen deficiency significantly influenced the growth followed by P, K, Ca, Fe, Mg, S, B, Zn & Cu. Plants grown in complete nutrient solution recorded maximum values for most growth parameters. Manganese has not much affected plant growth during the period of study in Gerbera var. Savannah.

ACKNOWLEDGEMENT

The financial support provided by S.K.L.T. Horticultural University in the form of stipend is duly acknowledged.

REFERENCES

1. *Anonymous. National Horticulture Data Base. 2014-15. National Horticulture Board. Ministry of Agriculture, Government of India.*
2. *Fredeen, A.L. Rao, I.M and Terry, N. 1989. Influence of phosphorous nutrition on growth and carbon partitioning in Glycine max. Plant physiology., 89: 225-230.*
3. *Hoagland, R.J and Arnon, D.I. 1950. The Water-Culture Method for Growing Plants without Soil, Circ. 347 (Rev. edition). California Agricultural Experimental Station, Berkeley, California.*
4. *Hossain, Md.D. Hanafi, Md. Jamal, T and Hamdan, J.2010. Effects of Nitrogen, Phosphorous and Potassium Levels on Kenaf (Hibiscus cannabinus L.) Growth and Photosynthesis under Nutrient Solution. Journal of Agricultural Science 2 (2):49-57.*
5. *Jeong, K.Y. Whipker, B.E.McCall, I. Gunter, C. 2009. Characterization of Nutrient Disorders of Gerbera Hybrid 'Festival Light Eye Pink'. International Society of Horticultural Science, Acta Hort. 843: 177-182*
6. *Julia, M.H. Stangoulis, J.C.R and Graham, R.D.2006. Manganese in A.V. Barker and D.J Pilbeam (eds) Hand book of Plant Nutrition, CRC press, eBook.351-366.*
7. *Keng, H.C, Wu, R.Y, Chang, G.P and Chung, R.S.2012. Effect of nitrogen concentration on growth and nutrient uptake of Anthurium andreanum Lind. Cultivated in coir under different seasonal conditions. Hort Science. 47(4): 515-521.*
8. *Lizarazo, M.A. Hernandez, C.A. Fischer, G and Gomez, M.I. 2013. Response of the banana passion fruit (Passiflora tripartite var. mollissima) to different levels of nitrogen, potassium and magnesium. Agronomia colombiana. 31(2): 184-194.*
9. *Prasad, A.L.N. 1987. Studies on the Nutritional Disorders of Chilli (Capsicum annum L.). College of Agriculture, Bapatla.*
10. *Salisbury, B.F and Ross, C.W. 1986. Plant physiology. CBS Publishers & Distributors, New Delhi. 96-106.*
11. *Sujatha K, Gowda J V N and Khan M M. 2002. Effects of different fertigation levels on gerbera under low cost greenhouse. J. Orn. Hort. 5(1): 54-59.*
12. *Taiz, L and Zeigar, E. 2003. Plant physiology. Panima Publishing Corporation, New Delhi. 67-76.*
13. *Uchida, R. 2000. Essential Nutrients for plant growth: Nutrient Functions and Deficiency Symptoms. College of Tropical Agriculture and Human Resources, University of Hawaii.*
14. *Yeh, D.M. Lin, L and Wright, C.J.2000. Effects of mineral nutrient deficiencies on leaf development, visual symptoms and shoot±root ratio of Spathyphyllum. Scientia Horticu lturae. 86 (2000): 223-233.*
15. *Zhang, B.G. Chen, Q.X. Yang, Q and Liu, K.D.2012. Effects of NPK deficiencies on root architecture and growth of cucumber. International Journal of Agriculture & Biology. 14: 145-148.*